



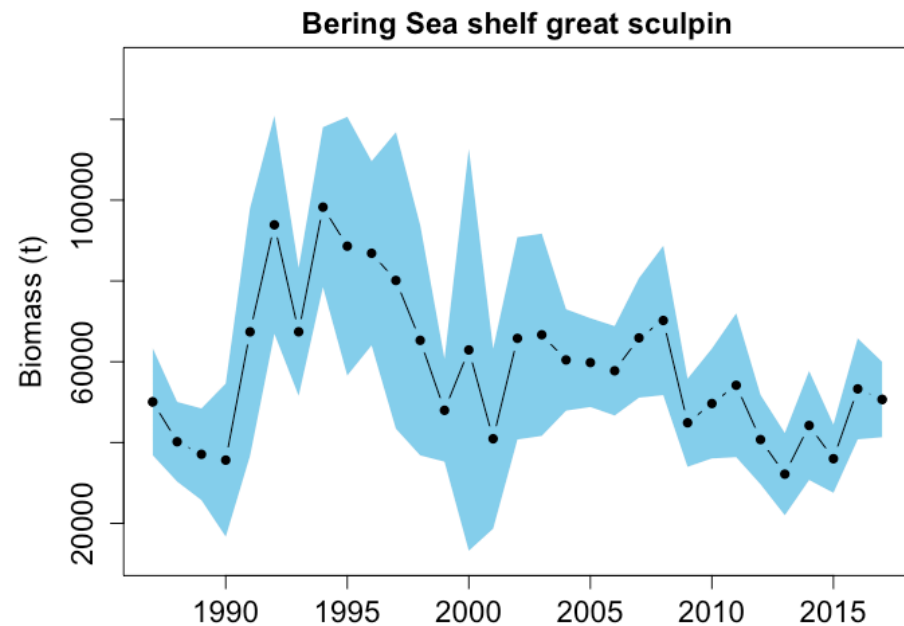
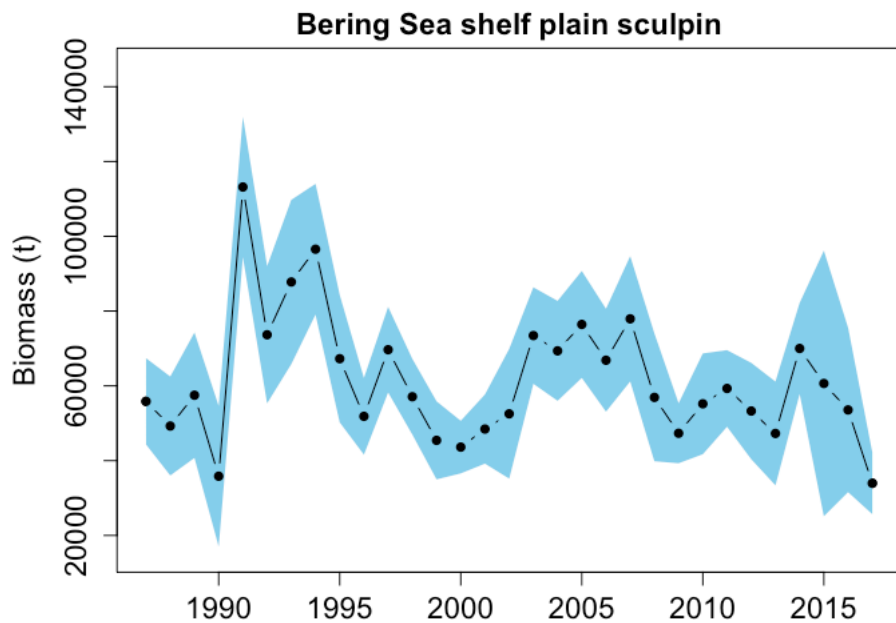
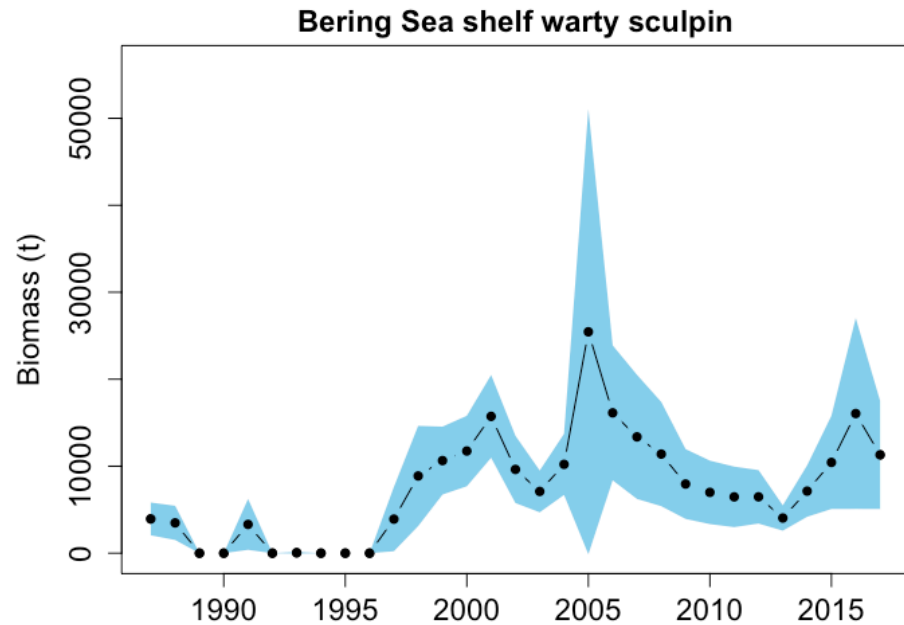
# Assessment of the sculpin stock complex in the Bering Sea and Aleutian Islands

Ingrid Spies, Dan Nichol, Kerim Aydin,  
and Todd T. TenBrink

Quantity	As estimated or <i>specified last year for:</i>		As estimated or <i>recommended this year for:</i>	
	2017	2018	2018	2019
<i>M</i> (natural mortality rate)*	0.283	0.283	0.283	0.283
Tier	5	5	5	5
Biomass (t)	199,937	199,937	199,937	199,937
$F_{OFL}$	0.283	0.283	0.283	0.283
$maxF_{ABC}$	0.212	0.212	0.212	0.212
$F_{ABC}$	0.212	0.212	0.212	0.212
OFL (t)	56,582	56,582	56,582	56,582
maxABC (t)	42,387	42,387	42,387	42,387
ABC (t)	42,387	42,387	42,387	42,387
Status	As determined <i>last year for:</i>		As determined <i>this year for:</i>	
	2015	2016	2016	2017
Overfishing	No	n/a	No	n/a

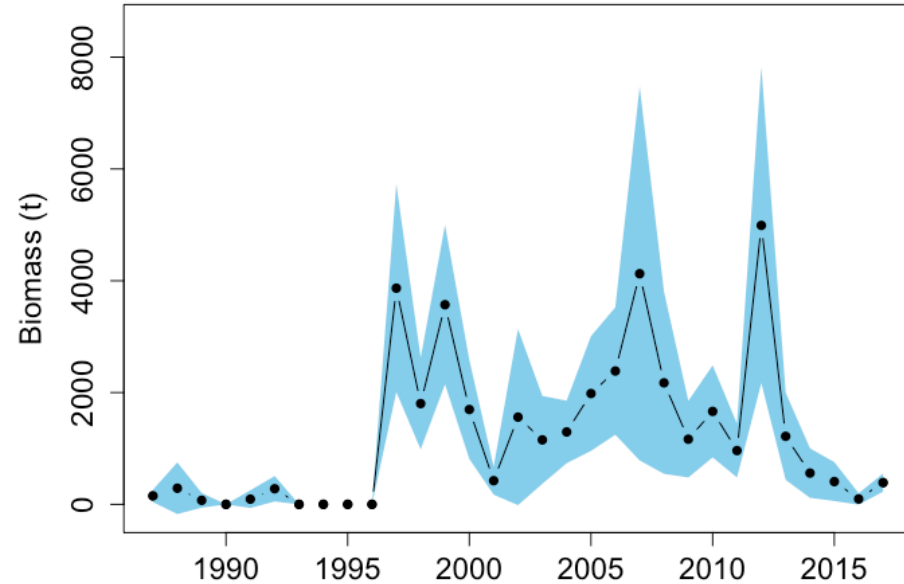
\* *The sculpin complex mortality rate is a biomass-weighted average of the instantaneous natural mortality rates for the six most abundant sculpins in the BSAI: bigmouth (Hemitripterus bolini), great (Myoxocephalus polyacanthocephalus), plain (Myoxocephalus jaok), threaded (Gymnocanthus pistilliger), warty (Myoxocephalus verrucosus/scorpius), and yellow Irish lord (Hemilepidotus jordani). The complex mortality rate may change as new survey data become available. See "results" section for more detail.*

# EBS shelf survey estimates of warty, plain, and great sculpin biomass through 2017

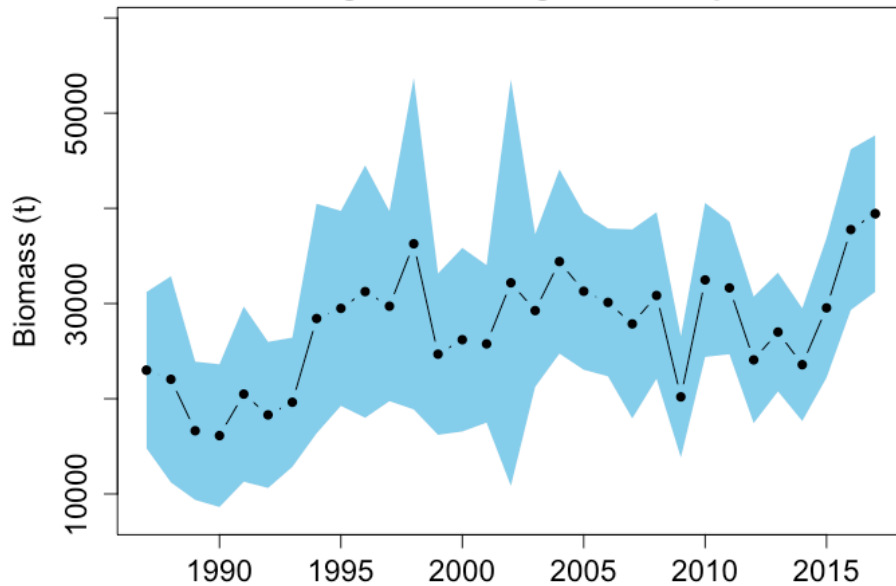


# EBS shelf survey estimates of threaded, bigmouth, and YIL biomass through 2017

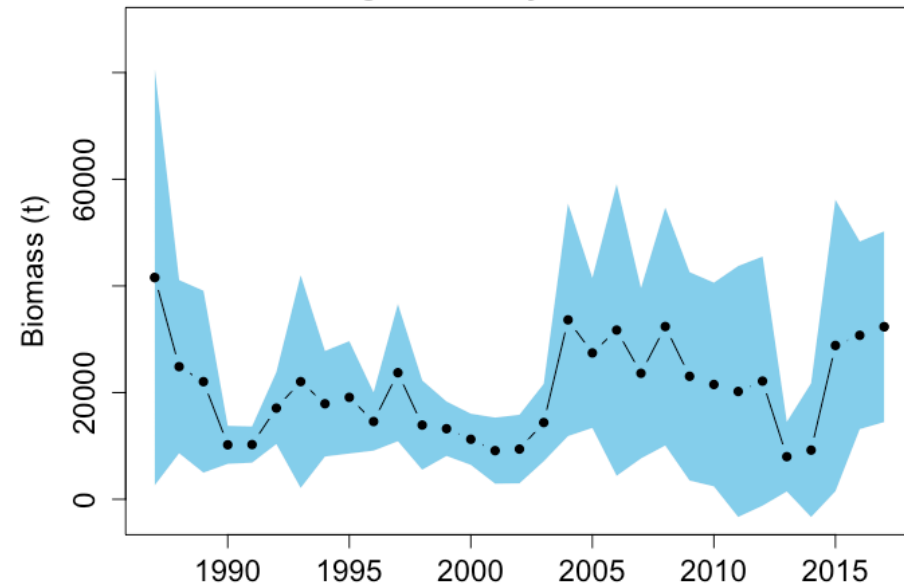
Bering Sea shelf threaded sculpin



Bering Sea shelf bigmouth sculpin



Bering Sea shelf yellow Irish lord



# Catch/biomass ratio (using the 2016 random effect biomass estimate)

Year	Biomass (t)	Catch (t)	Catch/biomass ratio
2004	221,282	6,042	0.03
2005	228,775	5,643	0.02
2006	227,798	5,729	0.03
2007	236,181	7,673	0.03
2008	223,315	7,389	0.03
2009	200,400	7,063	0.04
2010	202,174	5,434	0.03
2011	199,348	5,377	0.03
2012	183,942	5,798	0.03
2013	171,523	5,858	0.03
2014	189,359	4,879	0.03
2015	186,386	4,967	0.03
2016	199,937	4,892	0.02
2017*	199,937	4,698	0.02

\* The 2016 random effect model estimate for biomass was used for 2017.

# Using 2017 EBS shelf survey data to calculate new reference points

2017-2018 sculpin complex <i>M</i> harvest specification							
2017 random effects model estimate (EBS) 2016 for slope and AI					Relative proportion	<i>M</i>	weighted contribution to mort. est.
species	EBS shelf	EBS slope	AI	BSAI			
bigmouth	36,366	1,889	476	34,367	0.182	0.21	0.038
great	50,172	0	990	49,319	0.261	0.28	0.073
YIL	29,597	75	8,605	34,378	0.182	0.17	0.031
plain	37,340	0	0	57,753	0.306	0.40	0.122
threaded	367	0	0	148	0.001	0.45	0.000
warty	11,724	0	0	12,066	0.064	0.26	0.017
other	3,883	3,206	3,966	11,905		-	
<b>total</b>	<b>169,449</b>	<b>5,170</b>	<b>14,037</b>	<b>188,656</b>			<b>Complex <i>M</i>: 0.282</b>
<b>Total (6 most common species only):</b>				<b>177,601</b>			

# For comparison: Calculating reference points in 2016

## 2017-2018 sculpin complex $M$ harvest specification

### 2016 random effects model estimate

species	EBS shelf	EBS slope	AI	BSAI	Relative proportion	$M$	weighted contribution to mort. est.
bigmouth	32,002	1,889	476	34,367	0.183	0.21	0.038
great	48,329	0	990	49,319	0.262	0.28	0.073
YIL	25,698	75	8,605	34,378	0.183	0.17	0.031
plain	57,753	0	0	57,753	0.307	0.40	0.123
threaded	148	0	0	148	0.001	0.45	0.000
warty	12,066	0	0	12,066	0.064	0.26	0.017
other	4,733	3,206	3,966	11,905		-	
<b>total</b>	<b>180,729</b>	<b>5,170</b>	<b>14,037</b>	<b>199,937</b>			<b>Complex <math>M</math>: 0.283</b>
<b>Total (6 most common species only):</b>				<b>188,033</b>			

# Reference points using 2017 EBS shelf data

Quantity	As estimated or specified last year for:		As estimated or recommended this year for:	
	2017	2018	2018	2019
$M$ (natural mortality rate)*	0.283	0.283	0.282	0.282
Tier	5	5	5	5
Biomass (t)	199,937	199,937	188,656	188,656
$F_{OFL}$	0.283	0.283	0.282	0.282
$maxF_{ABC}$	0.212	0.212	0.212	0.212
$F_{ABC}$	0.212	0.212	0.212	0.212
OFL (t)	56,582	56,582	53,201	53,201
maxABC (t)	42,387	42,387	39,995	39,995
ABC (t)	42,387	42,387	39,995	39,995
Status	As determined last year for:		As determined this year for:	
	2015	2016	2016	2017
Overfishing	No	n/a	No	n/a



# EBS shelf biomass estimates

	YIL		bigmouth		great		plain		warty	
	biomass	CV	biomass	CV	biomass	CV	biomass	CV	biomass	CV
1982	52,700	0.33	22,841	0.22	6,026	0.29	58,297	0.19	*	
1983	46,475	0.40	19,945	0.21	37,989	0.27	86,344	0.16	2,008	0.63
1984	31,569	0.32	27,644	0.21	19,204	0.33	57,482	0.12	54,900	0.33
1985	13,116	0.24	14,219	0.22	30,234	0.19	37,122	0.10	1,985	0.78
1986	25,810	0.31	11,234	0.23	56,836	0.11	48,549	0.09	293	0.50
1987	41,574	0.48	22,996	0.18	50,845	0.13	55,852	0.11	3,938	0.24
1988	24,867	0.33	22,038	0.25	47,806	0.13	53,772	0.13	3,794	0.32
1989	22,047	0.39	16,636	0.22	37,244	0.16	57,857	0.15	*	
1990	10,212	0.18	16,123	0.24	37,573	0.26	36,991	0.26	*	
1991	10,258	0.17	20,483	0.23	67,848	0.23	113,180	0.08	3,306	0.45
1992	17,091	0.20	18,300	0.21	95,097	0.15	74,712	0.13	*	
1993	22,031	0.46	19,630	0.18	67,549	0.12	87,653	0.13	49	1.00
1994	17,911	0.28	28,426	0.22	99,271	0.10	44,319	0.15	*	
1995	19,112	0.28	29,492	0.18	88,622	0.18	67,240	0.13	*	
1996	14,573	0.19	31,250	0.22	90,999	0.13	54,096	0.10	*	
1997	23,727	0.28	29,722	0.17	85,371	0.24	73,287	0.08	3,915	0.48
1998	13,913	0.31	36,276	0.24	65,840	0.22	57,306	0.09	8,968	0.33
1999	13,229	0.20	24,681	0.18	50,039	0.14	47,324	0.12	11,090	0.19
2000	11,249	0.22	26,200	0.19	62,963	0.40	43,618	0.08	11,744	0.18
2001	9,121	0.35	25,760	0.16	41,071	0.28	48,449	0.10	15,726	0.15
2002	9,415	0.35	32,180	0.34	65,888	0.19	52,525	0.17	9,630	0.20
2003	14,205	0.25	29,161	0.14	67,357	0.19	80,187	0.09	7,098	0.17
2004	33,637	0.33	34,409	0.14	61,176	0.11	69,363	0.10	10,212	0.18
2005	27,444	0.26	31,289	0.13	60,100	0.09	76,426	0.10	25,500	0.51
2006	31,720	0.44	30,118	0.13	57,804	0.10	66,851	0.10	16,136	0.25
2007	23,765	0.34	27,859	0.18	66,000	0.11	77,922	0.11	13,370	0.27
2008	32,389	0.35	30,846	0.14	70,223	0.13	56,914	0.15	11,392	0.27
2009	23,056	0.43	20,196	0.16	44,901	0.12	47,322	0.09	7,952	0.26
2010	21,518	0.45	32,477	0.13	49,665	0.14	55,132	0.12	6,991	0.27
2011	20,212	0.59	31,643	0.11	54,177	0.17	59,306	0.09	6,472	0.27
2012	22,154	0.54	24,080	0.14	40,733	0.14	53,271	0.12	6,477	0.24
2013	7,990	0.42	27,005	0.12	32,185	0.16	47,273	0.15	4,040	0.18
2014	9,218	0.69	23,576	0.13	44,222	0.16	69,999	0.09	7,136	0.21
2015	28,835	0.48	29,542	0.13	36,000	0.12	60,641	0.30	10,436	0.26
2016	30,743	0.29	37,766	0.11	53,282	0.12	53,570	0.21	16,052	0.35
2017	32,351	0.28	39,438	0.11	50,668	0.09	33,962	0.12	11,305	0.28

# Random effects EBS shelf biomass estimates

Year	Bigmouth	Great	Plain	Warty	YIL	Threaded	Other
1987	21,042	46,813	55,139	3,789	25,634	157	19,707
1988	20,600	42,504	52,491	3,450	21,847	178	36,556
1989	19,995	42,334	57,727	3,090	17,126	125	43,767
1990	19,990	48,591	63,974	2,768	11,924	139	61,352
1991	20,609	62,431	101,100	2,479	11,640	155	47,511
1992	21,265	77,245	81,752	1,783	15,433	274	33,710
1993	22,526	75,383	87,048	1,283	17,172	454	26,421
1994	24,713	90,118	90,672	1,786	17,493	753	22,632
1995	26,472	87,090	69,122	2,487	17,450	1,249	12,746
1996	27,593	83,047	56,502	3,463	16,047	2,071	5,445
1997	28,156	74,198	66,177	4,823	17,715	3,433	8,204
1998	28,314	63,864	56,775	7,733	14,926	2,001	5,503
1999	27,541	54,321	47,300	10,281	13,258	3,253	7,010
2000	27,560	55,148	44,664	11,863	11,822	1,620	7,715
2001	27,894	54,736	48,917	14,342	11,340	569	6,407
2002	28,903	60,115	55,930	9,990	12,395	1,146	6,646
2003	29,718	61,989	70,324	7,892	15,952	1,177	4,560
2004	30,748	60,668	70,266	10,382	22,907	1,327	4,680
2005	30,470	59,872	74,320	14,749	25,570	1,941	7,613
2006	29,847	59,315	68,998	15,080	26,544	2,410	8,245
2007	29,117	63,149	72,374	13,098	25,728	3,286	6,389
2008	28,707	61,775	58,447	10,926	26,260	2,138	5,757
2009	27,547	50,211	49,544	8,374	23,713	1,306	6,521
2010	29,071	49,348	54,510	7,187	21,654	1,567	7,369
2011	29,066	48,092	57,938	6,531	19,818	1,149	7,429
2012	27,564	41,938	54,207	6,042	18,059	3,567	5,480
2013	27,584	38,052	53,250	4,705	15,580	1,284	3,785
2014	27,937	40,860	65,647	7,017	17,852	607	4,317
2015	30,699	40,284	57,256	9,910	22,930	378	5,432
2016	34,375	48,747	48,539	12,541	27,349	189	4,576
2017	36,366	50,172	37,340	11,724	29,597	367	3,883